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UTILITY PATENT APPLICATION TRANSMITTAL <small>(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))</small>	Attorney Docket No.	96794DIV3
	First Inventor or Application Identifier	Darryl L. Gamel
	Title	COMPONENT ALIGNMENT APPARATUSES..
	Express Mail Label No.	EE432138103US

APPLICATION ELEMENTS <small>See MPEP chapter 600 concerning utility patent application contents.</small>	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231	
1. <input checked="" type="checkbox"/> * Fee Transmittal Form (e.g., PTO/SB/17) <small>(Submit an original and a duplicate for fee processing)</small>	5. <input type="checkbox"/> Microfiche Computer Program (Appendix)	
2. <input checked="" type="checkbox"/> Specification [Total Pages 22] <small>(preferred arrangement set forth below)</small> <ul style="list-style-type: none">- Descriptive title of the Invention- Cross References to Related Applications- Statement Regarding Fed sponsored R & D- Reference to Microfiche Appendix- Background of the Invention- Brief Summary of the Invention- Brief Description of the Drawings (if filed)- Detailed Description- Claim(s)- Abstract of the Disclosure	6. <input type="checkbox"/> Nucleotide and/or Amino Acid Sequence Submission <small>(if applicable, all necessary)</small> <ul style="list-style-type: none">a. <input type="checkbox"/> Computer Readable Copyb. <input type="checkbox"/> Paper Copy (identical to computer copy)c. <input type="checkbox"/> Statement verifying identity of above copies	
3. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) [Total Sheets 4]	ACCOMPANYING APPLICATION PARTS 7. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) 8. <input type="checkbox"/> 37 C.F.R. § 3.73(b) Statement <input checked="" type="checkbox"/> Power of Attorney <small>(when there is an assignee)</small> 9. <input type="checkbox"/> English Translation Document (if applicable) 10. <input checked="" type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input checked="" type="checkbox"/> Copies of IDS Citations 11. <input checked="" type="checkbox"/> Preliminary Amendment 12. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) <small>(Should be specifically itemized)</small> 13. <input type="checkbox"/> * Small Entity Statement filed in prior application, Status still proper and desired (PTO/SB/09-12) 14. <input type="checkbox"/> Certified Copy of Priority Document(s) (if foreign priority is claimed) 15. <input checked="" type="checkbox"/> Other: Copy of Assignment previously filed & recorded in the USPTO	
4. Oath or Declaration [Total Pages 7] <ul style="list-style-type: none">a. <input type="checkbox"/> Newly executed (original or copy)b. <input checked="" type="checkbox"/> Copy from a prior application (37 C.F.R. § 1.63(d)) <small>(for continuation/divisional with Box 16 completed)</small><ul style="list-style-type: none">i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).		
* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).		
16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment: <input type="checkbox"/> Continuation <input checked="" type="checkbox"/> Divisional <input type="checkbox"/> Continuation-in-part (CIP) of prior application No: 08 / 915,862 Prior application information: Examiner Rushing Group / Art Unit: 3729 For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.		

17. CORRESPONDENCE ADDRESS					
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PATENT
96794DIV3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:
D. L. Gamel et al.

COMPONENT ALIGNMENT
APPARATUSES AND METHODS

PRELIMINARY AMENDMENT

Pittsburgh, Pennsylvania 15222
December 17, 1999

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Prior to the examination and prior to calculating the filing fee in the above-identified application (the "Subject Application"), please amend the Subject Application as follows:

In the Specification:

Please delete "APPARATUSES AND" from the Title.

After the CROSS-REFERENCE TO RELATED APPLICATIONS, please delete "Not Applicable" and insert -- This application is a divisional application of United States patent application serial number 08/915,862, filed August 21, 1997. -- therefor.

In the Abstract:

Please replace the Abstract with the following:

--

ABSTRACT

A method of placing a component having leads and an alignment indicating fiducial marker is provided. The method includes detecting the alignment of the fiducial marker on the component, comparing the detected fiducial alignment with a predetermined fiducial alignment and placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.--

In the Claims:

Please withdraw claims 2, 4 and 13-43.

All of the claims now pending in the application are reproduced below for the Examiner's convenience, whether they have been amended or not. Please amend the claims as indicated hereinbelow.

1. (Amended) A method of placing a component having leads and an alignment indicating fiducial marker to a substrate comprising:

[providing a fiducial marker on a component to be placed on a substrate that distinguishes the alignment of leads on the component;]

detecting the alignment of the fiducial marker on the component;

comparing the detected fiducial alignment with a predetermined fiducial alignment corresponding to a predetermined lead alignment; and[,]

placing the component to [a] the substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.

3. (Amended) The method of claim [2] 1, wherein the fiducial marker includes a physically asymmetric portion of the component and detecting the alignment further comprises:

[providing a nest having an asymmetrically shaped recess corresponding to the physically asymmetric marker on the component;

bringing] placing the component [and the] into a nest [into contact] having an asymmetrically shaped recess corresponding to the physically asymmetric marker on the component; and[,]

detecting whether the physically asymmetric marker on [said] the component mates with the asymmetrically shaped recess.

5. (Amended) The method of claim 3, wherein said detecting [the alignment includes providing a sensor within the recess to distinguish] further comprises distinguishing when [the leads or] the component [are] is in [the] a predetermined alignment.

6. (Amended) The method of claim 5, wherein [providing a sensor includes providing a vacuum sensor] said detecting further comprises:
creating a low pressure region in the recess; and
sensing a pressure in the low pressure region.

7. (Amended) The method of claim 5, wherein [providing a sensor 10 includes providing a contact sensor] said detecting further comprises sensing when a component contacts a surface of said recess.

8. (Amended) The method of claim 3, wherein said detecting [the alignment includes providing a receiver to detect] further comprises detecting whether the fiducial marker of the component mates with the asymmetrically shaped recess.

9. (Amended) The method of claim 8, wherein[:
]detecting the alignment further [includes positioning an emitter to]
comprises:
[direct] directing a pattern of radiation [toward] above and parallel to the recess in the nest; [and,]
[providing a receiver further includes providing a receiver in a position to receive emitted] receiving the radiation pattern that passes the recess;

[indicative of] comparing the received radiation pattern to a predetermined radiation pattern; and

determining whether the fiducial marker is mated with the asymmetrical shaped recess.

10. (Amended) The method of claim 1, [wherein providing a fiducial marker includes providing] further comprising forming a superficial asymmetric marker on said component.

11. (Amended) The method of claim 1, [wherein providing a fiducial marker] further [comprises] comprising forming [providing] multiple fiducial markers on said component.

12. The method of claim 1, wherein detecting the alignment further comprises detecting the fiducial marker visually.

Please add the following claims:

-- 44. A method of placing a component having leads and an alignment indicating fiducial marker, comprising:

detecting the alignment of the fiducial marker on the component;

comparing the detected fiducial alignment with a predetermined fiducial alignment; and

placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.

45. The method of claim 44, wherein the fiducial marker corresponds to an alignment of the leads of the component.

46. The method of claim 44, wherein said detecting further comprises detecting an orientation of the fiducial marker.

47. The method of claim 44, wherein said detecting further comprises detecting an orientation of the component.

48. The method of claim 44, wherein said placing the component further comprises placing a substrate in a component mounting area.

49. The method of claim 48, wherein said placing the component further comprises moving the component to the component mounting area.

50. The method of claim 44, further comprising discarding the component when the detected fiducial alignment does not correspond to the predetermined fiducial alignment.

51. The method of claim 44, further comprising halting operation of a component transfer apparatus when the detected fiducial alignment does not correspond to the predetermined fiducial alignment.

52. The method of claim 44, further comprising altering operation of a component transfer apparatus when the detected fiducial alignment does not correspond to the predetermined fiducial alignment.

53. The method of claim 44, further comprising continuously feeding components to the component feed assembly.

54. A method of placing a component having leads, comprising:
placing the component in a nest having a surface and an asymmetric recess defined therein;
detecting the alignment of the component in the recess;
comparing the detected alignment with a predetermined alignment; and
placing the component to a substrate when the detected alignment corresponds to the predetermined alignment.

55. The method of claim 54, wherein said detecting further comprises focusing an alignment detector on the surface of the nest.

56. The method of claim 54, wherein said detecting further comprises focusing an alignment detector above the nest.

57. The method of claim 54, wherein said detecting further comprises focusing an alignment detector parallel to and adjacent the surface of the nest.

58. The method of claim 54, further comprising picking the component from the nest.

59. The method of claim 58, further comprising aligning the component.

60. The method of claim 59, further comprising replacing the component in the recess of the nest.

61. A method of placing a component having leads and an alignment indicating fiducial marker shape, comprising:

detecting the alignment of the fiducial marker shape of the component;
comparing the detected fiducial alignment with a predetermined fiducial alignment; and

placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.

62. The method of claim 61, wherein said detecting further comprises:
forming a recess in a nest corresponding to the fiducial marker shape of the component; and

placing the component in the recess.

63. The method of claim 62, wherein said detecting further comprises determining whether the component extends beyond the surface of the nest.

64. The method of claim 61, wherein said forming a fiducial marker shape includes forming a beveled edge on the component.

65. A method of placing a component having leads and an alignment indicating fiducial marker, comprising:

- detecting the alignment of the fiducial marker on the component;
- comparing the detected fiducial alignment with a predetermined fiducial alignment;
- providing an alignment signal; and
- placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.

66. The method of claim 65, wherein said providing an alignment signal further comprises prompting an operator.

67. The method of claim 65, further comprising providing the alignment signal to a pick and place machine.

68. The method of claim 65, wherein the alignment signal corresponds to the presence or absence of a portion of a component extending beyond the nest surface.

69. The method of claim 65, wherein the alignment signal corresponds to whether the component is properly aligned in a recess of a nest.

70. The method of claim 65, further comprising affecting a control scheme in response to the alignment signal.

71. A method of placing a component having leads and an alignment indicating fiducial marker, comprising:

- directing a pattern of radiation across a nest having an asymmetric recess corresponding to an asymmetric shape of the component;
- sensing the radiation pattern passing across the nest;
- detecting the alignment of the fiducial marker on the component;

comparing the detected fiducial alignment with a predetermined fiducial alignment; and

placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.

72. The method of claim 71, wherein said directing further comprises disrupting the radiation pattern when a component is misaligned in the nest recess.

73. The method of claim 71, wherein said comparing further comprises comparing the radiation pattern passing across the nest to a known radiation pattern.

74. A method of placing a component having leads and an alignment indicating fiducial marker, comprising:

detecting the alignment of the fiducial marker on the component;
comparing the detected fiducial alignment with a predetermined fiducial alignment;
determining a component alignment from said comparison of the fiducial alignment with the predetermined alignment; and
placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment.

75. The method of claim 74, further comprising calculating a component position offset.

76. The method of claim 75, further comprising:
moving a nest from a first position into alignment with the component;
placing the component in the nest; and
returning the nest to the first position.

77. A method of placing a component having leads and an alignment indicating fiducial marker, comprising:

detecting the alignment of the fiducial marker on the component;
comparing the detected fiducial alignment with a predetermined fiducial

alignment;

causing a pick and place machine to pick the component; and
placing the component to a substrate when the detected fiducial alignment
corresponds to the predetermined fiducial alignment.

78. The method of claim 77, further comprising aligning the component when
the detected fiducial alignment does not correspond to the predetermined fiducial
alignment.

79. A method of placing a component having leads to a substrate, comprising:
detecting alignment of a fiducial marker on the component; and
placing the component to the substrate when the detected fiducial alignment
corresponds to a predetermined fiducial alignment.

80. A method of placing a component having leads to a substrate, comprising:
comparing an alignment of a fiducial marker on a component with a
predetermined fiducial alignment; and
placing the component to the substrate when the detected fiducial
alignment corresponds to the predetermined fiducial alignment.

81. The method of claim 80, further comprising aligning the fiducial marker
on the component with the predetermined fiducial alignment.

82. A method of placing a component having leads and an alignment indicating
fiducial marker, comprising:

detecting the alignment of the fiducial marker on the component;
comparing the detected fiducial alignment with a predetermined fiducial
alignment;

aligning the component so that the fiducial marker corresponds to the
predetermined fiducial alignment; and

placing the component to the substrate when the detected fiducial alignment
corresponds to the predetermined fiducial alignment.--

REMARKS

Status of the Application

The Subject Application is a divisional application based on U.S. Patent Application Serial No. 08/915,862, filed August 21, 1997 (the "Parent Application").

In the Parent Application, the Examiner required election of one of the following inventions:

- IA. Claims 1 through 12, drawn to a method of placing a component having leads to a substrate;
- IB. Claim 13, drawn to a method of attaching a component to a substrate;
- IC. Claim 14, drawn to a method of verifying a predetermined lead alignment of a component;
- ID. Claims 15 through 20, drawn to a method of picking a component having a predetermined lead alignment;
- IIA. Claims 21 and 41, drawn to a component alignment detection apparatus;
- IIB. Claims 22 through 29, 42 and 43 drawn to an apparatus for moving components;
- IIC. Claims 30 through 37, drawn to an apparatus for moving components; and
- IID. Claims 38 through 40, drawn to an apparatus for moving components.

In response to that restriction requirement, claims 21 and 41 were elected and the remaining claims were withdrawn from the Parent Application. Accordingly, the Subject Application is directed to subject matter related to Invention IA, claims 1-12 of the Parent Application.

Amendments to the Abstract

Applicant requests that the abstract of the Subject Application be replaced with the amended abstract presented hereinabove. The abstract has been amended so as to be directed toward the subject matter claimed in the Subject Application.

Amendments to the Specification

Applicant requests that the Specification of the Subject Application be amended as indicated hereinabove. The Title is amended to be descriptive of the Subject Application. The second amendment to the Specification presented hereinabove is presented to indicate that the Subject Application is a divisional application of the Parent Application.

Claim Amendments

Original claims 2, 4 and 13-43 have been withdrawn herein to advance the prosecution of the Subject Application, and without admitting the propriety of any rejections or objections to those claims. Claims 1, 3 and 5-11 are amended hereinabove to clarify the subject matter claimed. Therefore, Applicant respectfully requests that those amendments be entered.

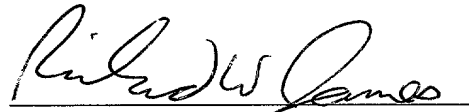
New Claims

Applicant requests that new claims 44-82, support for which may be found throughout the specification, be added to the Subject Application.

Conclusion

Applicant submits that no new matter is introduced in the amendments proposed hereinabove and respectfully requests that the Examiner enter those amendments prior to the examination of the Subject Application. Furthermore, examination and passage to allowance of the Subject Application at an early date is earnestly solicited.

Respectfully submitted,



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TITLE OF THE INVENTION
Component Alignment Apparatuses and Methods

INVENTOR

5 Darryl L. Gamel
Kreg W. Hines

CROSS-REFERENCE TO RELATED APPLICATIONS

Not Applicable

10 STATEMENT REGARDING FEDERALLY SPONSORED
RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

15 The present invention relates generally to detecting the
orientation of a body. More particularly, the present
invention relates to alignment apparatuses and methods for
determining whether leads on a semiconductor package are
aligned in a predetermined alignment prior to placement on
20 and attachment to a substrate. The invention can be
generally used in conjunction with or integral to pick and
place machines, such as surface mount placement machines, die
attach machines, tape and reel production machines, wire bond
machines, and the like, to verify proper lead alignment on
25 components being placed by the machines.

Solid state electrical devices are typically produced by
attaching a plurality of miniaturized electrical components
to a common substrate, such as a printed circuit board. The
proper performance of the device is dependent upon the
30 precise placement of each electrical component on the
substrate.

The placement of electrical components on a substrate is
commonly performed using machines generally known as pick and
place machines. Pick and place machines typically employ a
35 number of movable heads each having a nozzle through which a
negative pressure, preferably a vacuum, is applied to pick a

component from a feed source, such as a continuous tape and reel assembly. The pick and place machine controls the movement of each head to precisely place the components on a substrate, after which the vacuum or suction is released.

5 Commonly, pick and place machines incorporate sensor systems that detect whether a component is properly aligned in a predetermined angular orientation prior to placing. Examples of such systems are discussed in U.S. Patent No. 5,040,291 issued to Janisiewicz ("291 patent") and 5,377,405
10 issued to Sakurai et al.

Other placement systems ensure alignment of the component by providing either a recessed surface in a substrate shaped to receive the component or mating surfaces on the component and the substrate. For example, See U.S.
15 Patent No. 5,034,802 issued to Liebes, et al. (the "'802 patent"). The '802 patent also discloses the use of an alignment jig for aligning a component prior to picking and placing the component on the substrate. The alignment jigs employ large recesses that are tapered down to the dimensions
20 of the component. The large tapered recess allows the components to be placed less precisely in the jig. The taper on the jig then serves to essentially "funnel" the components into a precise alignment.

A problem exists with the aforementioned alignment
25 methods when used with traditional rectangular shaped components having leads extending from two opposing sides. If the component is 180° out of alignment, the leads will appear to be properly aligned using the above methods. A component that has its leads attached 180° out of alignment
30 will generally function improperly at a minimum and may result in damage to the component and/or other components connected to the component. The obvious exception is a component that is designed to employ mirror image lead connections, which is not the typical design.

This problem is further complicated by components that are designed to have symmetric leads on more than two sides, such as a square shaped component. A 90° rotation of a square shaped component in the plane of the leads will result in a lead misalignment that is undetectable using prior art methods.

The misalignment of leads on aligned components is a defective condition that is presently not detectable using general component orientation systems of the prior art. Thus, the present invention is directed to detecting the misalignment of lead components irrespective of the general orientation of the component to provide apparatuses and methods that can be used to determine the lead alignment of components prior to placement on and attachment to a substrate.

BRIEF SUMMARY OF THE INVENTION

The above objectives and others are accomplished by methods and apparatuses in accordance with the present invention. A method of the present invention contemplates placing a component having leads to a substrate by providing a fiducial marker on a component to be placed on a substrate that uniquely distinguishes the alignment of leads on the component. The alignment of the fiducial marker on the component is detected and compared to a predetermined fiducial alignment corresponding to a predetermined lead alignment. The component is placed on the substrate when the detected fiducial alignment corresponds to the predetermined fiducial alignment. In addition, a component that has misaligned leads can be discarded or the alignment of the components can be properly realigned in accordance with an alignment offset.

Apparatuses of the present invention can be operated in conjunction with or integral to various pick and place machines, such as surface mount placement machines, die

attach machines, tape and reel production machines, and wire bond machines. Generally, the apparatus includes a nest for receiving a component and detector positioned to detect whether leads on the component in the nest are properly aligned and provide a signal indicative of the alignment. In a preferred embodiment, a physically asymmetric fiducial marker is provided on the component and a correspondingly asymmetric recess is provided in a surface of the nest. The detector is positioned to detect whether the asymmetric portions of the component and the nest mate. In another embodiment, a receiver is positioned in a pick and place machine relative to the feed source to detect the alignment of the leads on a component prior to the component being fed to a pick station for placement on a substrate.

Accordingly, the present invention overcomes the aforementioned problems to provide apparatuses and methods that provide the ability to determine, verify, and/or correct the alignment of leads on components prior to placing the components on a substrate. These advantages and others will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying Figures wherein like members bear like reference numerals and wherein:

Figs. 1(a) & 1(b) show two lead arrangements on components including fiducial markers that can be aligned using the present invention;

Fig. 2 is an example of a pick and place apparatus incorporating the present invention;

Fig. 3 shows a side view along the line 3-3 shown in Fig. 2 and including a misaligned component seated in the recess in the nest;

Fig. 4 is a cross section of the nest shown in Fig. 3 along the line 4-4, but with a properly aligned component seated in the recess of the nest;

Fig. 5 shows an alternative embodiment of the device for
5 detecting a physical asymmetry on the component;

Fig. 6 is a perspective view of an apparatus of the present invention including a component having both superficial and physically asymmetric marks; and,

Fig. 7 is a further example of a pick and place
10 apparatus incorporating the present invention.

DETAILED DESCRIPTION OF THE INVENTION

An apparatus 10 embodying the present invention will be described generally with reference to the drawings for the purpose of illustrating the present preferred embodiments of
15 the invention only and not for purposes of limiting the same. The apparatus 10 generally includes a nest 12 and a detector 14. The nest 12 and detector 14 are used in combination with a component 2 having leads 4 by providing a fiducial marker 6 on the component 2, as shown in Figs. 1(a)&(b), to determine
20 or verify whether the leads 4 are properly aligned prior to placing the component 2 on a substrate 8. The fiducial marker 6 is provided on the component 2 in such a way to uniquely distinguish the alignment of the leads 4. Unless specifically stated, the term "fiducial marker" is meant to
25 include any number and all types of marks that serve the distinguishing function, discussed above, either in isolation or combination. Such marks may include, but are not limited to, geometric shapes or characters that superficially and/or structurally alter the appearance of the component 2.

30 In a preferred embodiment, the nest 12 includes a nest surface 16 containing an asymmetric recess 18 that corresponds to a component having a physically asymmetric fiducial marker 6. Physically corresponding fiducial markers 6 and nests 12 are currently preferred due, in part, to the

fact that most semiconductor components are manufactured with a physical asymmetry to facilitate post-production troubleshooting operations. Therefore, the manufacturing process for many components does not have to be modified to
5 work with the present invention.

Many electrical components are currently manufactured with a physically asymmetric beveled edge that provides a convenient way for inspection and maintenance personnel to quickly ascertain the post-production configuration of a
10 component as it is assembled in a machine. The use of beveled edges and other asymmetries in the prior art has represented an additional manufacturing step and expense that did not improve the overall quality or cost effectiveness of the manufacturing process. As such, an objective of the
15 prior art has traditionally been to eliminate the beveled edge thereby decreasing manufacturing costs.

An asymmetric portion 20 is preferably incorporated in the recess 18. The asymmetric portion 20 is sized to correspond to and mate with the physically asymmetric
20 fiducial marker 6 on the component 2 when the leads 4 are properly aligned for placement on the substrate and the component 2 and nest 12 are brought into contact. Preferably, the component 2, when properly seated in the recess 18, will not extend beyond the nest surface 16. This
25 provides for a digital (on/off) detection scheme in that the component 2 is detected only if the leads are misaligned. Alternatively, the recess 18 can be designed so the component 2 extends beyond the surface 16 to produce a profile characteristic of a component having properly aligned leads.
30 If the component 2 does not properly mate with the recess 18, the component 2 will produce a profile that is not characteristic of a component with properly aligned leads.

The detector 14 of the present invention is positioned relative to the nest 12 to detect the alignment of the leads
35 4 and provide alignment signals or data indicative of the

component alignment. Generally, the lead alignment is detected implicitly by detecting either the orientation of the fiducial marker or the component 2 relative to the nest surface 16. The alignment signal provided by the detector 14
5 can be used to prompt an operator or as a control signal for additional operations as will be discussed in greater detail within.

In a preferred embodiment shown in Figs. 2 and 3, the detector 14 includes an emitter 22 and a receiver 24. The
10 emitter 22 is positioned to emit radiation, preferably visible or infrared light, parallel and proximate to the nest surface 16. The receiver 24 is positioned on a side of the recess 18 opposite the emitter 22 to receive the emitted radiation directed toward the recess 18. The position of the
15 receiver 24 is such that a misalignment of the components will result in a disruption of a radiation pattern received by the receiver 24. The receiver 24, in turn, provides the alignment signals indicative of the component alignment.

The receiver 24 preferably includes a reference
20 radiation pattern for a properly aligned component. The reference pattern is compared with a radiation pattern received by the receiver 24 to determine the lead alignment of the component 2. For example, in the preferred embodiment, the comparison is made to determine the presence
25 or absence of a portion of the component 2 extending beyond the nest surface 16. The absence of the component 2 blocking the emitted signal from the receiver 24 is indicative that the leads of the component in the nest 12 are properly aligned.

Any number of emitter/receiver combinations can be used
30 with the present invention. In an alternative embodiment for the detector 14, shown in Figs. 4 and 5, a sensor 25 is positioned within the recess 18 at a location to discriminate between components with properly and improperly aligned leads
35 when the nest 12 and the component 2 are brought into contact

and provide alignment signals accordingly. The sensor 25 can be one or more of various types of sensors, such as contact, electrical, mechanical, pressure or environmental, but is preferably a vacuum sensor as shown in Fig. 4. It can be appreciated that the sensor can also be used in such conjunction with emitter/receiver detectors 14 such as in Fig. 3.

In addition, a receiver 24, such as a camera, can be used that does not require a dedicated emitter. As shown in Fig. 6, a camera 24 can be used as the detector 14 for components having either physical or superficial asymmetric fiducial markers 6 with or without a nest 12. The camera is used to detect both the location and orientation of the fiducial marker 6 for comparison with a properly aligned fiducial marker 6. In this embodiment, a recess in the nest 12 may or may not be used in determining the alignment of the component 2. As shown in Fig. 7, the apparatus 10 can be incorporated into existing machinery through the placement of the camera 24 in a position to detect a fiducial marker indicating the alignment of the leads. One skilled in the art will appreciate that other receivers 24 that do not require dedicated emitters 22 can be similarly incorporated.

In the arrangement of Fig. 6, the detector 14 can be used to facilitate realignment of the component 2 through the use of a movable nest 12 and a feedback system 26. The feedback system 26 controls the movement of the nest 12 based on the comparison of the actual and proper alignment of the fiducial marker 6. The alignment comparison provides an alignment offset for use in correcting the alignment either prior to or during placement of the component 2 on the substrate 8. The feedback system 26 can also be used to halt or alter a process involving the apparatus 10, if the component 2 is misaligned or the alignment of the component 2 can not be determined.

One skilled in the art will appreciate that a feedback system can be implemented in any of the embodiments described herein. For example, a feedback system for components having physical asymmetries may involve picking up and realigning the component 2 to properly seat the component 2 in the nest 12. Alternatively, the nest 12 can be temporarily adjusted to properly seat the component 2 and then readjusted to its properly aligned position prior to removal of the component 2 for further processing.

An exemplary implementation of the apparatus 10 is to modify pick and place machines 30 of the prior art, such as shown in Fig. 2. The machine 30 is further described in the '291 patent, the disclosure of which is hereby incorporated by reference. In this particular embodiment, the machine 30 includes a pick spindle 32 and a placement spindle 34, each of which contains a plurality of pick heads 36.

The pick spindle 32 employs the pick heads 36 to remove components 2 from a pick station 38 and place them in a spindle transfer area 40. Generally, components are continuously fed to the pick station 38 using a continuous track of trays 42 that are supplied from a feed source 44, such as a continuous tape reel 46. The feed source 44 may also include a plurality of serial feed tracks in addition to the single serial feed track shown in Figs. 2 and 7. The spindle transfer area 40 is accessible by pick heads 36 from both the pick spindle 32 and the placement spindle 34.

The placement spindle 34 employs the pick heads 36 to pick the components 2 from the spindle transfer area 40 and place the components 2 on the substrate 8 positioned in a component mounting position 48. Generally, the substrate 8 will be fed to and removed from the component mounting position 48 along a track 50 in a continuous feed assembly.

The machine 30 generally includes a controller 52 and a number of additional components to bring about high speed movement of components. For example, the machines generally

employ a variety of actuators 54 to move the pick heads 36 between pick and place locations.

In a first embodiment shown in Fig. 2, the apparatus 10 is positioned in the spindle transfer area 40. Generally, the apparatus 10 will be connected to the controller 52 and operate to affect the control scheme of the controller 52 in response to alignment signals provided by the detector 14.

Alternatively, the apparatus can have a controller that is independent of the machine controller 52. For example, embodiments of the apparatus 10 employing the feedback system 26 can use the alignment signals to provide continual monitoring of the alignment verification process independent of the machine controller 52. The feedback system 26 communicates with the controller 52 providing misalignment conditions. The controller 52 can be suitably modified to perform any number of actions as specified in response to the alignment signals received either directly from the detector 14 or from the feedback system 26. Such actions include, but are not limited to, repicking the misaligned component using the pick head 36 and replacing it in the nest 12 after realigning the component. Also, the placement spindle can be used to place the misaligned component in a discard area (not shown) or can place the component on the substrate in accordance with an alignment offset required to properly align the leads 4. The alignment offset is determined by comparing the detected alignment with the predetermined alignment for the component having its leads properly oriented.

A general description of the operation of the machine 30 employing the apparatus 10 is provided. Initially, components 2 are fed from the feed source 44 to the pick station 38 via a continuous series of trays 42. The components 2 are picked from trays 42 at the pick station 38 using the pick heads 36 on the pick spindle 32. The pick spindle 32 moves to the spindle transfer area 40 and places

the components in the nests 12. Alternatively, the component 2 can be placed into the transfer area 40 and the nest 12 and the component 2 can be brought into contact.

5 The detector 14 provides alignment signals or data on whether components 2 are properly placed in the nest 12. If the leads 4 on the components 2 are properly aligned, the placement spindle 34 picks the components 2 from the nest 12. The placement spindle moves the components to the mounting position 48 and places the components 2 on the substrate.

10 An alternative embodiment of the apparatus 10 in a different pick and place machine 130 described in the '291 patent is shown in Fig. 7. Machine elements that are comparable to those in machine 30 have the same last two digits in the reference number. In machine 130, the spindle transfer area 40 and placement spindle 34 used in the
15 embodiment shown in Fig. 2 have been eliminated. The components 2 are picked from trays 142 using pick heads 136 on a pick spindle 132. The pick spindle 132 places the components 2 on the substrate 8 at the component mounting
20 station position 148.

The apparatus 10 is embodied as a receiver 24 positioned relative to the feed source 144 and connected to a machine controller 152. The receiver 24 is used to detect the location of a fiducial marker 6 on the component 2 while the
25 component 2 is in the tray 142. If the leads 4 on the component 2 are not properly aligned, the pick heads can be used to correct the alignment offset of the component or discard the misaligned component. Alternatively, the controller 152 can control the pick spindle 132 to bypass the
30 misaligned component. The misaligned component will be transported away from the pick station 138 in the tray 142. A remote apparatus can be provided to realign or discard the misaligned component.

The positioning of the receiver 24 in the embodiment of
35 Fig. 7 allows one receiver to inspect the components 2 as the

components are transported to the pick station 138 on a continuous track. One receiver 24 can then provide lead alignment data for use by the controller 152 in directing pick operations. Also, as discussed above, the receiver 24
5 can be used to detect both physical asymmetries and superficial asymmetries on the components 2.

One skilled in the art will appreciate the receiver 24 can be arranged in a stationary position relative to the feed source 144 or the receiver 24 can be coupled with the
10 movement of the pick head 36. Also, a plurality of receivers 24 can be used that correspond to one or more of a plurality of pick heads. In addition, components 2 can also be fed to the pick stations using parallel feed sources, which also may be either continuous or discontinuous.

Embodiments similar to Fig. 7 provide substantial flexibility in upgrading existing pick and place machines to incorporate the apparatuses and methods of the present invention. However, those apparatuses perform most reliably if the fiducial marker 6 is visually accessible while the
20 component 2 is in the tray 142. It should be noted that the tray 142 can also be modified to serve as a nest 12 for visually inaccessible physical asymmetries.

Those of ordinary skill in the art will appreciate that a number of modifications and variations that can be made to specific aspects of the method and apparatus of the present invention without departing from the scope of the present
25 invention. Such modifications and variations are intended to be covered by the foregoing specification and the following claims.

CLAIMS

What is claimed is:

1. A method of placing a component having leads to a substrate comprising:

5 providing a fiducial marker on a component to be placed on a substrate that distinguishes the alignment of leads on the component;

 detecting the alignment of the fiducial marker on the component;

10 comparing the detected fiducial alignment with a predetermined fiducial alignment corresponding to a predetermined lead alignment; and,

 placing the component to a substrate when the detected fiducial alignment corresponds to the predetermined fiducial
15 alignment.

2. The method of claim 1, wherein providing a fiducial marker includes providing a physically asymmetric marker.

20 3. The method of claim 2, wherein detecting the alignment further comprises:

 providing a nest having an asymmetrically shaped recess corresponding to the physically asymmetric marker on the component;

25 bringing the component and the nest into contact; and, detecting whether the physically asymmetric marker on said component mates with the asymmetrically shaped recess.

30 4. The method of claim 3, wherein bringing the components includes placing the component in the nest.

5. The method of claim 3, wherein detecting the alignment includes providing a sensor within the recess to distinguish when the leads or the component are in the predetermined alignment.

5

6. The method of claim 5, wherein providing a sensor includes providing a vacuum sensor.

7. The method of claim 5, wherein providing a sensor includes providing a contact sensor.

8. The method of claim 3, wherein detecting the alignment includes providing a receiver to detect whether the fiducial marker mates with the asymmetrically shaped recess.

15

9. The method of claim 8, wherein:

detecting the alignment further includes positioning an emitter to direct radiation toward the recess in the nest; and,

providing a receiver further includes providing a receiver in a position to receive emitted radiation indicative of whether the fiducial marker is mated with the asymmetrical shaped recess.

10. The method of claim 1, wherein providing a fiducial marker includes providing a superficial asymmetric marker.

11. The method of claim 1, wherein providing a fiducial marker further comprises providing multiple fiducial markers.

30

12. The method of claim 1, wherein detecting the alignment further comprises detecting the fiducial marker visually.

13. A method of attaching a component to a substrate comprising:

providing a fiducial marker on a component to be placed on a substrate that distinguishes the alignment of leads on the component;

detecting the alignment of the fiducial marker on the component;

comparing the detected alignment with a predetermined fiducial alignment to determine an alignment offset;

adjusting the position of the component relative to the substrate to eliminate the alignment offset; and, attaching the component to the substrate.

14. A method of verifying a predetermined lead alignment of a component comprising:

providing a physical asymmetry on a component to be placed on a substrate that distinguishes the alignment of leads on the component;

providing a nest containing a recess that corresponds to and mates with the physical asymmetry on the component when the leads on the component have a predetermined alignment;

placing the component in the nest; and,

detecting whether the physical asymmetry has mated with the recess to verify the lead alignment.

15. A method of picking a component having a predetermined lead alignment comprising:

providing a fiducial marker on a component that distinguishes the alignment of leads on the component;

detecting the alignment of the fiducial marker;

comparing the detected alignment with a predetermined fiducial alignment to determine an alignment offset necessary to pick the component in accordance with the predetermined lead alignment; and,

picking the component in accordance with the alignment offset.

16. The method of claim 15, wherein picking the
5 component comprises:
positioning a pick head in accordance with the alignment offset; and,
picking the component using the pick head.

10 17. The method of claim 15, wherein picking the component comprises:
picking the component using a pick head; and,
orienting the pick head and component in accordance with the alignment offset.

15 18 The method of claim 15, wherein:
providing a fiducial marker further comprises providing a superficial fiducial marker; and,
detecting the alignment further comprises detecting
20 visually the superficial fiducial marker.

19. The method of claim 15, wherein providing a fiducial marker includes providing a physically asymmetric fiducial marker.

25 20 The method of claim 15, wherein picking the component further comprises:
moving a pick head proximate to the component; and,
applying a negative pressure through the pick head
30 sufficient to hold the component against the pick head.

21. A component alignment detection apparatus comprising:

a nest including a nest surface containing an asymmetric recess; and,

5 a detector positioned to detect an alignment of a component placed in said recess, compare said detected alignment with a known alignment, and provide an alignment signal indicative of whether said detected alignment corresponds with said known alignment.

10

22. An apparatus for moving components comprising:

a pick and place machine including a movable pick head configured to pick components and having access to an asymmetric recess in a nest;

15 a component feed source configured to supply components to said recess; and,

a detector positioned to detect an alignment of a component placed in said recess, compare said detected alignment with a known alignment, and provide an alignment
20 signal indicative of whether said detected alignment corresponds with said known alignment.

23. The apparatus of claim 22, wherein said detector is connected to control said pick and place machine in response
25 to said comparison.

24. The apparatus of claim 22, wherein said detector is further positioned in a plane substantially parallel and proximate to a surface of said nest containing said recess.

30

25. The apparatus of claim 22, wherein said pick and place machine comprises a machine selected from the group consisting of surface mount placement machines, die attach machines, tape and reel production machines, and wire bond machines.

26. The apparatus of claim 22, wherein said recess corresponds to a shape of a component being picked using said pick head.

27. The apparatus of claim 22, wherein said detector comprises:

a nest containing a physically asymmetric recess; and
a sensor positioned with said recess.

28. The apparatus of claim 27, wherein said sensor is selected from the group consisting of pressure sensors, contact sensors, electrical sensors, mechanical sensors, thermal sensors and other environmental sensors.

29. The apparatus of claim 27, wherein said sensor comprises a vacuum sensor.

30. An apparatus for moving components comprising:

a pick and place machine including a controller connected to a movable pick head and a component feed source, said pick head having access to said component feed source; and,

a detector comprising a receiver directed toward said feed source to detect an alignment of a component, said controller being connected to said receiver and configured to compare the detected component alignment with a known component alignment.

31. The apparatus of claim 30, wherein said component feed source comprises a continuous serial track component feed source.

5 32. The apparatus of claim 31, wherein said continuous serial track component feed source further comprises a plurality of component trays serially disposed along said track.

10 33. The apparatus of claim 32, wherein said plurality of component trays contains a recess having an asymmetric shape.

15 34. The apparatus of claim 30, wherein said feed source further comprises a plurality of serial feed sources.

20 35. The apparatus of claim 34, wherein said detector further comprises a plurality of receivers and each of said plurality of serial feed sources has at least one corresponding receiver positioned to detect an alignment of a component in said serial feed source.

25 36. The apparatus of claim 30, wherein said detector and said pick head are distinct members.

37. The apparatus of claim 30, wherein said detector is stationary with respect to said pick head.

38. An apparatus for moving components comprising:

a pick and place machine including,

a pick station connected to a component feed source,

a first pick head having access to said pick station

5 and a component transfer area,

a second pick head having access to said component transfer area and a component mounting position,

a detector positioned to detect an alignment of a component in said component transfer area, and

10 a controller connected to said feed source, said first pick head, said second pick head, and said detector and said controller being configured to compare the detected component alignment with a known component alignment and control said feed source, said first pick head, and said
15 second pick head in response to said comparison.

39. The apparatus of claim 38 wherein said detector comprises:

a nest that is accessible by said first and second pick
20 heads; and,

a receiver positioned to detect an alignment of a component placed in said nest and compare said detected alignment with a known alignment.

25 40. The apparatus of claim 39 wherein:

said nest includes a nest surface containing an asymmetrically shaped recess;

said detector further comprises an emitter positioned to direct radiation toward said recess in a generally parallel
30 direction adjacent to said nest surface; and,

said receiver is positioned on a side of said recess opposite to said emitter to receive radiation from said emitter directed toward to said recess.

41. An apparatus for detecting alignment of a component having an asymmetric shape, comprising:

a nest including a nest surface containing an asymmetric recess corresponding to the shape of said component; and,

5 a detector positioned to detect whether said component is completely received in said recess and provide an alignment signal indicative of whether said component was completely received.

10 42. An apparatus for moving components, comprising:

a nest including a nest surface containing an asymmetric recess corresponding to asymmetrically shaped components;

a pick and place machine including a movable pick head configured to pick components from said asymmetric recess in
15 a nest;

a component feed source configured to serially supply said components to said recess; and,

a detector positioned to detect whether said component supplied to said recess is completely received in said recess
20 and provide an alignment signal indicative of whether said component was completely received.

43. The apparatus of claim 42, wherein said detector is connected to control said pick and place machine in response
25 to whether said component is detected as being completely received in said recess.

ABSTRACT OF THE DISCLOSURE

Apparatuses and methods are disclosed for determining the alignment of leads on components. Physical and/or
5 superficial fiducial markers on components are used to distinguishes the alignment of leads on the component. The alignment of fiducial markers on the component are detected. A predetermined fiducial alignment is provided that corresponds to a predetermined lead alignment. The detected
10 fiducial alignment is compared to a predetermined fiducial alignment to determine the lead alignment. When used in conjunction with a pick and place machine, the methods and apparatuses provide a means for verifying and correcting the lead alignment of components prior to placement and
15 attachment to a substrate.

$$F: g. \quad 1(b)$$

Fig. 2

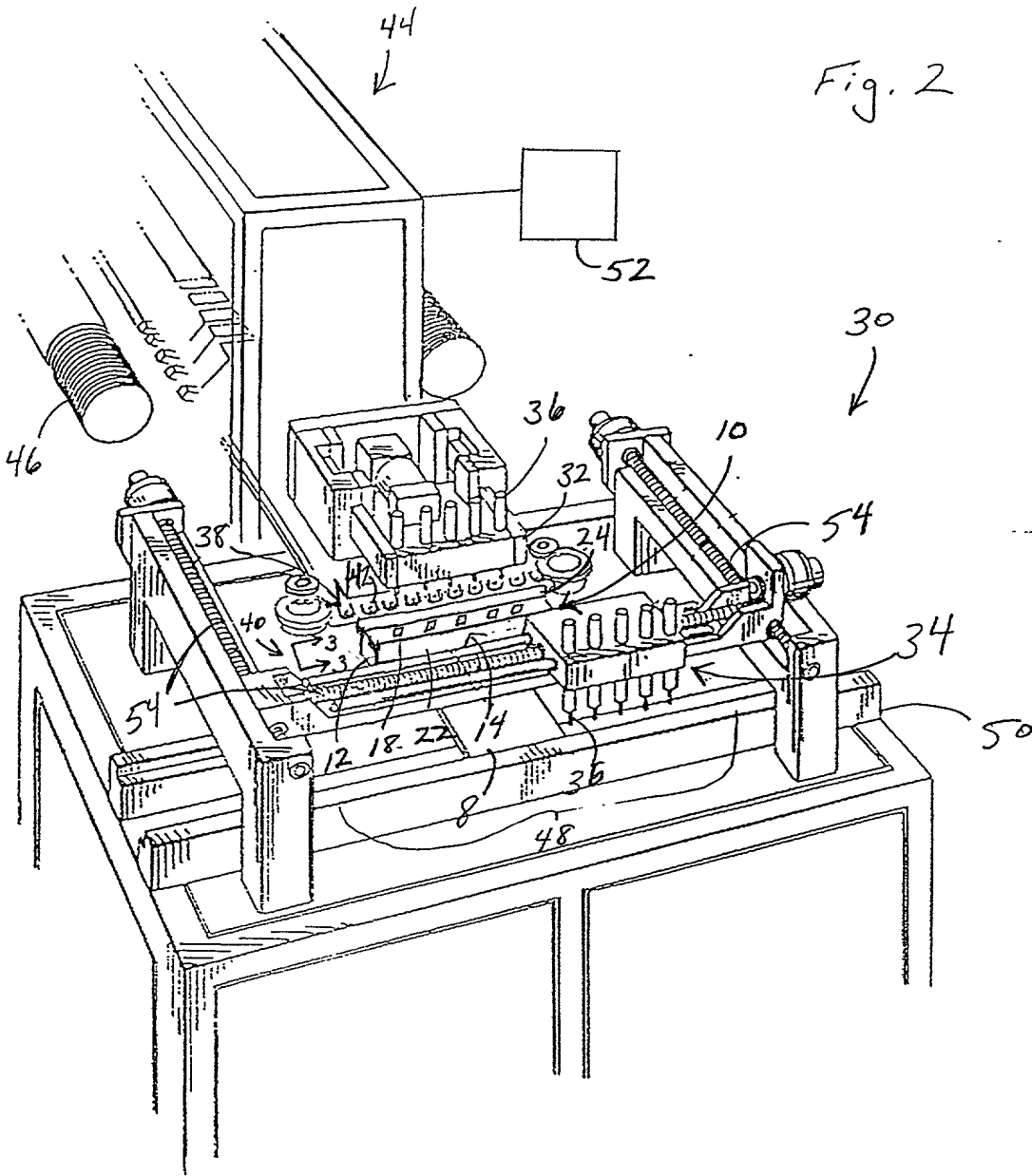


Fig. 3

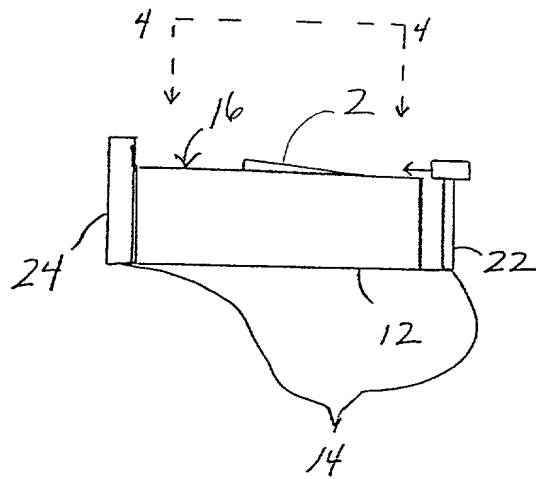


Fig. 4

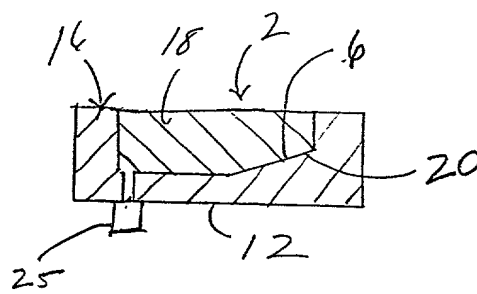


Fig. 6

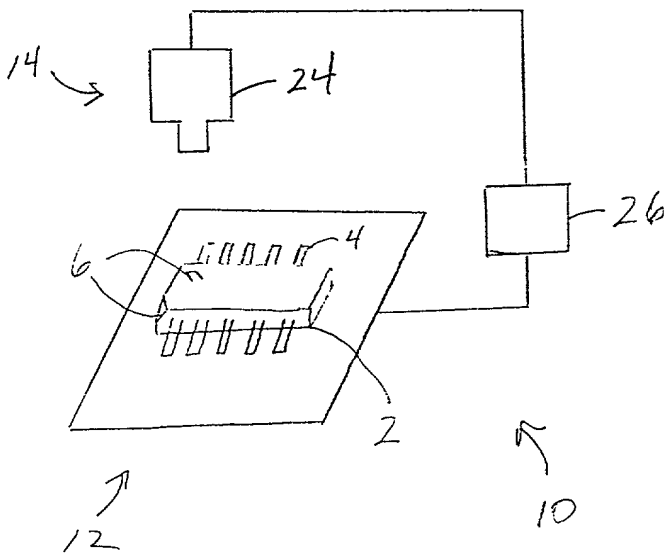
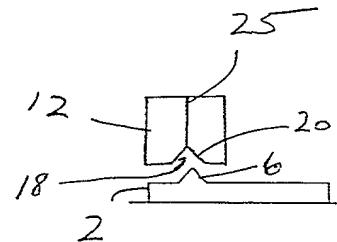


Fig. 5



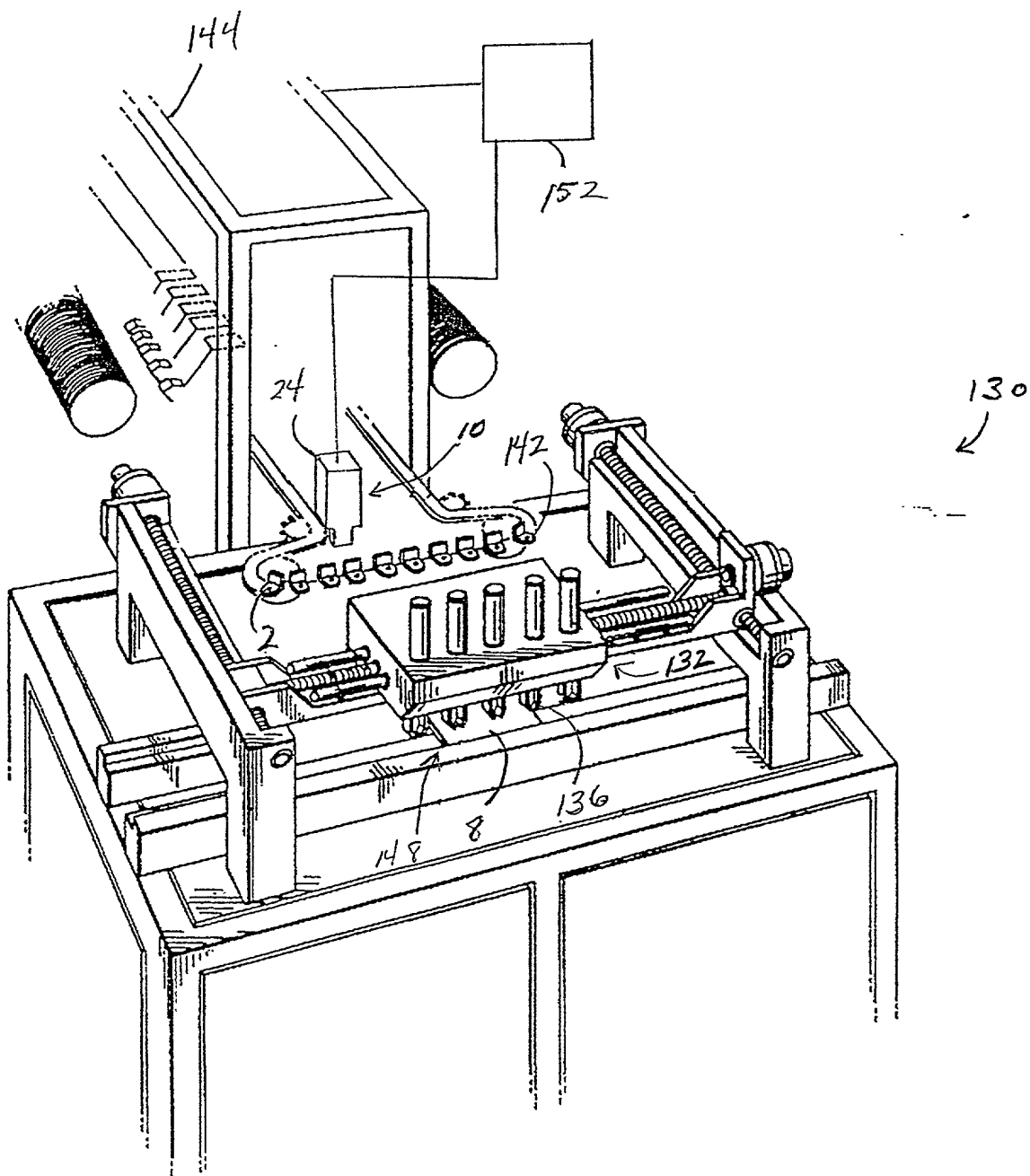


Fig. 7

ATTORNEY'S DOCKET NO. 96794

PATENT

COMBINED DECLARATION AND POWER OF ATTORNEY
(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,
CONTINUATION OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type:

(check one applicable item below)

- ☒ original.
- ☐ design.
- ☐ supplemental.

NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of the last three items.

- ☐ national stage of PCT.

NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.

- ☐ divisional.
- ☐ continuation.
- ☐ continuation-in-part (C-I-P).

INVENTORSHIP IDENTIFICATION

WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time that the last claimed invention was made, should be submitted.

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (*if only one name is listed below*) or an original, first and joint inventor (*if plural names are listed below*) of the subject matter that is claimed, and for which a patent I sought on the invention entitled:

TITLE OF INVENTION

____ COMPONENT ALIGNMENT APPARATUSES & METHODS _____

(Declaration and Power of Attorney [1-1]—page 1 of 7)

SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b) or (c))

(a) ☒ is attached hereto.

NOTE: "The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed; or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1995 (1177 O.G. 60).

(b) ☐ was filed on _____, as ☐ Serial No. 0 / _____ or
☐ _____
and was amended on _____ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(2) name of inventor(s), serial number and filing date;

"(3) name of inventor(s) and attorney docket number which was on the specification as filed;

"(4) name of inventor(s), title which was on the specification as filed and filing date;

"(5) name of inventor(s), title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(6) name of inventor(s), title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

Notice of July 13, 1995 (1177 O.G. 60).

- (c) ☐ was described and claimed in PCT International Application No. _____,
filed on _____ and as amended under PCT Article 19 on
_____ (if any).

ACKNOWLEDGMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

(also check the following items, if desired)

- ☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent, and
- ☒ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 CFR 1.98.

PRIORITY CLAIM (35 U.S.C. § 119(a)-(d))

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (d) or (e))

- (d) ☒ no such applications have been filed.
- (e) ☐ such applications have been filed as follows.

NOTE: Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
			<input type="checkbox"/> YES NO <input type="checkbox"/>
			<input type="checkbox"/> YES NO <input type="checkbox"/>
			<input type="checkbox"/> YES NO <input type="checkbox"/>
			<input type="checkbox"/> YES NO <input type="checkbox"/>
			<input type="checkbox"/> YES NO <input type="checkbox"/>

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(34 U.S.C. § 119(e))**

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER

FILING DATE

**CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S)
UNDER 35 U.S.C. 120**

- ☐ The claim for the benefit of any such applications are set forth in the attached **ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN PART (C-I-P) APPLICATION.**

**ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

NOTE: *If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.*

POWER OF ATTORNEY

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Michael C. Antone, Reg. No. 39,094; Tara C. Cacciabauda, Reg. No. P-40,935; George D. Dickos, Reg. No. 30,048; Thomas J. Edgington, Reg. No. 34,324; Christine R. Ethridge, Reg. No. 30,557; Jason D. Haislmaier, Reg. No. 40,300; James R. Kyper, Reg. No. 27,346; Mark R. Leslie, Reg. No. 36,360; Franklin B. Molin, Reg. No. 37,397; Jonathan C. Parks, Reg. No. 40,120; Edward L. Pencoske, Reg. No. 9,688; Darren E. Wolf, Reg. No. 36,310 and Robert D. Yeager, Reg. No. 25,047. Michael I. Lynch, Reg. No. 30,871 and Lia M. Pappas, Reg. No. 34,095.

☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named attorney(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

MICHAEL C. ANTONE
KIRKPATRICK & LOCKHART LLP
1500 OLIVER BUILDING
PITTSBURGH, PA 15222

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)
MICHAEL C. ANTONE
412-355-8375

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(Declaration and Power of Attorney [1-1]--page 5 of 7)

SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor:

Darryl W. Gamel
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)
Inventor's signature [Signature]
Date 8/20/97 Country of Citizenship USA
Residence 1840 Ballantyne 2113 ROANOKE
Post Office Address Eagle, Idaho 83616 Boise ID 83712

Full name of second joint inventor, if any

Kreg W. Hines
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)
Inventor's signature KREG W HINES
Date 8/20/97 Country of Citizenship U.S.A.
Residence 1962 North Sparkling Place
Post Office Address Boise, Idaho 83642

Full name of third joint inventor, if any

(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)
Inventor's signature _____
Date _____ Country of Citizenship _____
Residence _____
Post Office Address _____

(check proper box(es) for any of the following added page(s)
that form a part of this declaration)

☐ **Signature for fourth and subsequent joint inventors. *Number of pages added***
_____.

* * *

☐ **Signature by administrator(trix), or legal representative for deceased or
incapacitated inventor. *Number of pages added*** _____.

* * *

☐ **Signature for inventor who refuses to sign or cannot be reached by person
authorized under 37 CFR 1.47. *Number of pages added*** _____.

☐ **Added page for signature by one joint inventor on behalf of deceased
inventor(s) where legal representative cannot be appointed in time.
(37 CFR 1.47)**

☐ **Added pages to combined declaration and power of attorney for divisional,
continuation, or continuation-in-part (C-I-P) application.**

☐ **Number of pages added** _____

* * *

☐ **Authorization of attorney(s) to accept and follow instructions from representative.**

* * *

*(if no further pages form a part of this Declaration,
then end this Declaration with this page and check the following item)*

☒ **This declaration ends with this page.**